NON-ANADROMOUS

CHANNEL AND RIPARIAN ASSESSMENT
For Specific Reaches of Upper McKinney Creek

Assessment Process

The goal of this assessment is to use our understanding of riparian habitat function and to use local scientific information to design a biologically effective watercourse and lake protection zone. The stream channel and riparian habitat assessment is intended to describe and assess site specific stream channel and riparian conditions. From this data collection and assessment the site specific prescriptions necessary to maintain a healthy stream channel and riparian habitats can be designed. As appropriate and prudent, specific effectiveness monitoring may be selected to provide scientific validation of the assessment. The assessment, prescriptions and any effectiveness monitoring are to be used as an adaptive management tool. Adaptive management is designed to provide feedback on whether channel and riparian conditions were maintained or enhanced as predicted.

Non-Anadromous Reach of Upper McKinney Creek

The McKinney Creek watershed which flows into the Klamath River is known historically (pre-1980) to support anadromous salmonids including coho salmon and steelhead trout. Currently, based on opportunistic electro-shocking of Lower McKinney Creek by the California Department of Fish and Game, neither coho salmon or steelhead trout are known to occupy the lower reaches of the watershed. In April 2001, a barrier to anadromous salmonid distribution was found in Lower McKinney Creek. The natural barrier is located approximately in the NW ¼ of Section 21 and is approximately 2.0 miles upstream from the confluence of McKinney Creek with the Klamath river. The natural barrier was reviewed by the California Department of Fish and Game (Mr. Dennis Maria) and was determined to be a natural and permanent barrier to anadromous salmonid distribution. Consequently, the following assessment process and design of effective watercourse and lake protection zones (WLPZ) are being completed for a non-anadromous stream channel.

Overview of Riparian Habitat Concepts

Riparian habitats can provide numerous functions that help maintain productive aquatic habitats. Research has found that the riparian vegetation provides five key functions: stream channel shade, nutrients, filtration of sediment, recruitment of large woody debris for fish habitat and stream bank stability (Spence et al, 1996; FEMAT 1993; McDade et al, 1990). Many effects of riparian vegetation on streams decrease with increasing distance from the streambank (Beschta et al. 1987). These distances can be influenced by the degree of channel constraint, floodplain width, tree species and overall vegetation site quality.

Generalized curves have been developed that describe the distances at which each key function influences stream channel habitats (Spence et al, 1996; FEMAT 1993). If specific stream channel information is available, results may indicate that these generalized curves need modification. Results from the Alsea Watershed Studies in Oregon found that effective riparian shade buffers from partially harvested riparian habitats occurs between 25 feet to 100 feet wide (Brown 1971) but that riparian shade could potentially influence streams equal to one site-potential tree height (Beschta et al. 1987). The effectiveness of riparian habitats to deliver leaf and other particulate organic matter begins to decline at distances greater than approximately one-half a tree height away from the channel (FEMAT 1993). Filtration of sediment from overland flow occurs by physical barriers that trap sediment like vegetation and down woody debris which occurs at distances equal to one site-potential tree height (FEMAT 1993). The majority of large woody debris that helps form fish habitat is recruited at relatively close distances to the stream channel (Murphy and Koski (1989)), however, large woody debris can potentially enter the stream channel from up to one site potential tree height (FEMAT 1993). And finally, stream bank stability is maintained through tree and

vegetation root strength at distances less than one-half a tree crown diameter (Burroughs and Thomas 1977). When managing riparian habitats all five of these key factors should be assessed and considered in development of the forest management prescriptions.

In addition to understanding the natural processes at work within riparian habitats it is important to assess other more stochastic natural processes. Riparian habitats are typically changed by disturbances such as fire and windthrow. Riparian habitats are also changed through channel disturbances such as lateral channel erosion, peak flow flooding and deposition of debris during peak flows. These disturbances help create a relatively highly diverse plant and tree community (Gregory et al. 1991). Accordingly, condition of site specific riparian habitats and frequency of local stochastic events may be reviewed in this channel assessment.

(1) Riparian Shade

Effective riparian shade that maintains stream water temperatures can be achieved between 25 feet to 100 feet from the stream channel (Brown 1971) and was verified in a cause-and-effect study in Oregon (Brown 1972). However, riparian shade could potentially influence streams equal to one site-potential tree height (Beschta et al. 1987). Also, local site specific riparian conditions including topography, channel orientation, channel width, forest composition and forest density all influence shading of stream channels (Beschta et al. 1987). Stream temperatures may also be influenced by elevation, the presence or absence of ground water springs and local air temperatures (Quigley et al, 2001; Sullivan et al, 1990).

This assessment of riparian shade and the potential of proposed forest management prescriptions to modify riparian shade and stream water temperatures will include: (a) aerial photo review of watershed level stream shade, (b) review of previous forest management plans that modified riparian shade, (c) review of stream water temperatures, and (d) assessment of proposed forest management prescriptions.

(a) Watershed Level Stream Shade

Using aerial photos a watershed level stream channel assessment was completed for McKinney Creek following standard *Watershed Analysis methodology* (DNR 1995). Stream reach levels of shade (canopy closure) were identified and determined using *Watershed Analysis methodology Table D-9* for riparian function. McKinney Creek was assessed from the confluence with the Klamath River to the headwaters. The stream had a total of 19 distinct individual riparian reaches over a total of 43,500 feet or 8.2 miles (Table 1). A total of 84% of the reaches had canopy closure over 70% and 90% of the reaches had canopy closure over 40%. Riparian shaded in Lower and Upper McKinney Creek is formed by both conifer and hardwood riparian shade. Hardwood riparian shade, primarily from red alder, provides shade directly over the stream channel which moderates water temperatures. Both Lower and Upper McKinney Creek have long reaches of riparian shade exceeding 70% canopy closure.

Table 1 Results of *Watershed Analysis* methodology of Upper McKinney Creek

Aerial Photo Percent Estimated Shade	Number of Stream Reaches	Length of Stream Reaches	Percent of Length
> 90%	8	28,700	66%
70 - 90 %	6	7,900	18%
40 - 70 %	3	2,700	6%
20 – 40 %	0	0	0%
0 – 20 %	1	500[1]	1%
Class III Headwater	1	3,700	9%
TOTAL	19	43,500	100%

[1] All 0-20% canopy closure reach along agricultural field at confluence with Klamath River.

(b) Forest Management Modification of Riparian Shade

As part of the Cumulative Impacts Assessment (Section IV) previous timber harvest plans that have operated within the watershed assessment area are listed. Some of these timber harvest plans have operated in riparian habitats which modified riparian shade. A portion of these are also tributary to stream temperature sensor locations collected since 1997. Table 2 lists the timber harvest plans, units and riparian shade quantities that have been modified that are also upstream of stream temperature sensors. Note Class III streams are not included in this assessment due to the lack of stream water flow during peak of summer water temperatures.

Table 2 Riparian Management along Tributary streams.

Year of Operation	Tributary Hobo Location	Harvest Plan Unit #	Length Class I (feet)	Canopy Closure Class I (%)	Length Class II (feet)	Canopy Closure Class II (%)
1997 (2-97-313)	Upper McKinney Creek	15	1,956	100% [a]	0	0
	Upper McKinney Creek	34, 35, 36	0	0	2,517	50[b]
	Upper McKinney Creek	16	0	0	858	50[b]
	Upper McKinney Creek	11	0	0	497	50[b]
2004	Upper McKinney Creek	4	0	0	460	50-70% [c]
Total	**Upper McKinney Creek**		1,956		4,332	

[a] Class I WLPZ Pre -Threatened and Impaired measures = width was 75'to 150' no harvest buffer.
[b] Class II WLPZ Pre-Threatened and Impaired measures = width was 50 feet to 100 feet and 50% of overstory and understory canopy covering the ground.
[c] Class II WLPZ width was 25 feet (70% canopy closure) and next 75 feet (50% canopy closure).

In summary, a total of 1,956 feet of Class I riparian habitat and 4,332 feet of Class II riparian habitat has been modified since 1997 tributary to the McKinney Creek water temperature sensor. It should be noted that several other small private landowners have completed timber harvesting along McKinney Creek since 1997. These timber harvest plans would be located above the McKinney Creek water temperature sensor, so our results represent a conservative estimate of the amount of riparian habitat modified between 1997 and 2005.

(c) Review of Stream Water Temperatures

Measurement of stream water temperatures is commonly completed using continuous running temperature monitoring sensors (Quigley et al., 2001; Sullivan et al., 1990). Stream temperatures were collected using HOBO H8 temperatures sensors. These sensors were set to collect streams temperatures every 90 minutes which is suitable to detect stream temperature peaks (Lewis et al., 2000). These sensors are accurate to $\pm$ 0.5C and have been calibrated to a NIST traceable thermometer (ASTM# 6016). Site selection, field protocols, calibration and maintenance of sensors followed recommended protocols and standards described in Lewis et al., 2000.

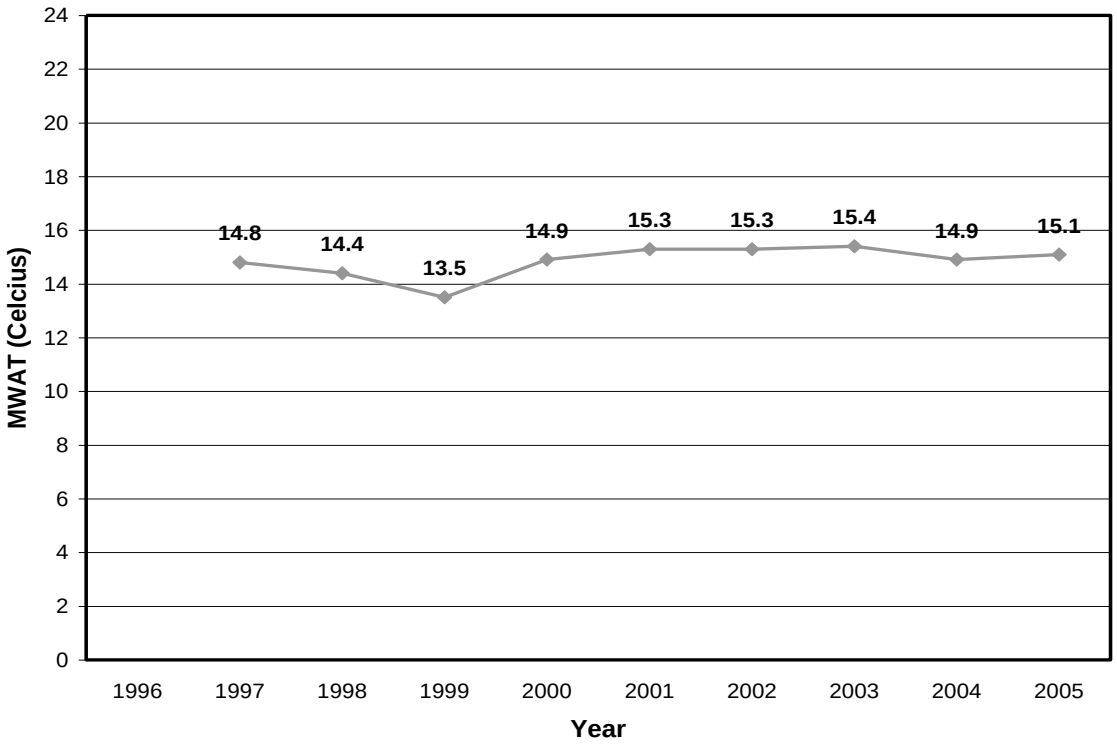
Since 1997 stream water temperatures have been collected at one location in the Upper McKinney Creek watershed. The results from this location has the sampling year, sampling period, the dates of the peak temperatures described by the 7-day Maximum Weekly Average Temperature (MWAT) and the MWAT calculated in Celsius and Fahrenheit. The stream water temperature locations have been identified as Upper McKinney Creek (TMK02)(Table 3)(Figure 1).

Table 3 Upper McKinney Creek (TMK02)

Calendar Year	Sampling Period	7-day MWAT Period	MWAT[1] C° and F°
1997	6/12 to 11/13	8/4 to 8/10	14.8C (58.9F)
1998	5/21 to 11/30	7/21 to 7/27	14.4C (58.2F)
1999	5/27 to 12/6	8/24 to 8/30	13.5C (47.3F)
2000	6/2 to 9/8	7/28 to 8/3	14.9C (59.1F)
2001	7/9 to 10/9	8/7 to 8/13	15.3C (59.8F)
2002	6/27 to 10/9	7/10 to 7/16	15.3C (59.8F)
2003	6/3 to 9/22	7/27 to 8/2	15.1C (59.5F)
2004	6/1 to 9/21	7/22 to 7/28	14.9C (59.1F)
2005	6/6 to 9/26	8/2 to 8/8	15.1C (59.5F)

1 MWAT is the Maximum Weekly Average Temperature

Figure 1 Upper McKinney Creek (TMK02)



In conclusion, stream water temperatures have remained relatively unchanged during the 1997 through 2005 monitoring period. Annual differences in summer peak air temperatures have influenced stream water temperatures throughout Siskiyou County including Upper McKinney Creek. The relatively mild summer of 1999 and record breaking heat of the summer of 2003 are evident in our monitoring results.

(d) Assessment of proposed forest management prescription

Results of temperature monitoring indicate that previous timber harvest within riparian habitats does not appear to have increased stream water temperatures. The Upper McKinney Creek stream temperatures (MWAT) have remained unchanged from the harvest of 1,956 feet of Class I riparian habitat modified from 1997 to 2005 (Figure 1). The Upper McKinney Creek stream temperatures (MWAT) have remained unchanged from the harvest of 4,332 feet of Class II riparian habitat modified between 1997 to 2005 (Figure 1). In conclusion, stream water temperatures do not appear to have been either increased or decreased due to previous riparian habitat management (Table 2) that included no harvest buffers along Class I streams and retention of 50%-70% canopy closure along Class II streams.

These results and conclusions are similar to other studies. In the Alsea watershed studies in Oregon, it was shown that shade nearest the stream channel (25 feet) most effectively shaded the stream to achieve moderate stream water temperatures (Brown 1970; Brown et al. 1971). Brown et al (1971) also concluded that managed vegetation buffers between 25-100 feet along streams can be as effective as undisturbed forest in maintaining stream water temperatures. On going research being conducted in California has presented preliminary results showing that clearcut harvesting of riparian habitats between 75 feet and 150 feet from the stream channel have maintained stream water temperatures (James, 2004).

The watershed level assessment of riparian conditions along Upper McKinney Creek found a very high percentage (84%) of reaches with greater than 70% canopy closure. A relatively short reach (500 feet) that contains 0-20% canopy closure is located along a historical mine and curret agricultural field at confluence with Klamath River. Assessment of aerial photography taken in 1944, 1964, 1971 and 2001 indicates McKinney Creek riparian habitats have recovered from lower amounts of dense canopy closure in 1964 (39%) to high amounts of dense canopy closure in 2001 (84%).

Assessment of the Proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Water Class **Slope %**	**Class I** **WLPZ width (feet)**	**Protection Measures**	**Canopy Closure**
All Slope Classes	0 to 50 feet	Q	100% retention of existing canopy closure No harvest Alternative
All Slope Classes	50 to 150 feet	Q	50% Canopy closure

Based on the site specific observed stream temperatures and habitat assessment does the proposed WLPZ and SOZ prescriptions meet or exceed the protection measures described under 936.4(b) for vegetation structure and 936.9(a) and 936.9(i) for the beneficial function of riparian zones?

☒ Yes ☐ No Explain and justify proposal or explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

(1) The proposal provides no harvest of riparian shade in the closest 50 feet most important to maintaining stream temperatures.
(2) Beyond 50 feet, the proposal will provide riparian shade which could potentially provide additional maintenance of stream temperatures.
(3) The proposed WLPZ and SOZ are designed from the results of water temperature monitoring which indicate the proposed WLPZ and SOZ will **meet** existing riparian habitat standards by maintaining existing water temperatures.

(2) Nutrients: Leaf and Other Particulate Organic Matter Input

Nutrients from organic matter enter the stream channel primarily as leaf fall. Nutrients can also be recruited into the stream channel during high stream flow events that flow over alluvial flood plains. The delivery of leaf and other particulate organic matter is also influence by the presence of hardwood versus conifer trees. Riparian vegetation also regulates the exchange of nutrients and material from upland forests to streams (Gregory et al. 1991). Due to contribution of organic matter the riparian habitats are also an important component of the aquatic ecosystem food base (Bilby and Likens 1980). In general, the effectiveness of riparian habitats to deliver leaf and other particulate organic matter begins to decline at distances greater than approximately one-half a tree height away from the channel (Spence 1996; FEMAT 1993). Based on the local site tree height delivery of nutrients and other organic matter is expected to occur up to 60 feet from the stream channel (one-half tree height).

Assessment of the proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Based on the site specific observed habitat conditions and assessment does the proposed WLPZ and SOZ prescriptions meet or exceed the protection measures described under 936.4(b) for vegetation structure and 936.9(a) and 936.9(i) for the beneficial function of riparian zones?

☒ Yes ☐ No Explain and justify or explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

The proposed WLPZ and SOZ were designed based on the scientific understanding of nutrient delivery into stream channels. The proposed measures retain 100% of all vegetation and conifer and hardwoods trees for nutrient delivery within 50 feet of the stream channel. An additional 50% canopy closure beyond 50 feet would also potentially deliver nutrients to the stream channel. Based on the scientific information presented in this assessment the WLPZ and SOZ design **exceeds** the protection measures required in CCR 936.9.

(3) Filtration of Sediment: Maintaining Water Quality

In general, filtration of sediment from overland flow occurs by physical barriers that trap sediment such as ground vegetation and down woody debris and occurs at distances equal to one site-potential tree height (FEMAT 1993). Local riparian effectiveness of filtration varies as a function of geomorphic characteristics such as slope and soil type and by vegetative structure and cover. Vegetation retained during the 1997 timber harvest plan included 50% canopy closure (100 feet) along Class I streams and 50% vegetation cover (50 feet) along Class II streams. And vegetation retained during the 2001 timber harvest plan included 85% canopy closure (75 feet) and 65% canopy closure (for an additional 75 feet) along Class I streams and 70% canopy closure (25 feet) and 50% canopy closure (for an additional 25-75 feet) for Class II streams. In addition these previous riparian habitats were protected through the use of Equipment Exclusion Zones which left understory vegetation, down logs, rocks and forest floor litter intact as physical barriers to filter any potential sediment from overland flow.

Assessment of the proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Do the measures proposed by this alternative WLPZ and SOZ based on the site specific observed habitat conditions and assessment ensure the proposed WLPZ and SOZ prescriptions meet or exceed riparian sediment filtration function?

☒ Yes ☐ No Explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

(1)The proposed WLPZ and SOZ were designed based on the scientific understanding of filtration of sediment by riparian habitats.
(2)The proposed measures retain 100% of all vegetation and conifer and hardwoods trees, down logs, rocks and forest floor litter for filtration within 50 feet of the stream channel.
(3)An additional 50% canopy closure for the remaining zone width and the use of an Equipment Limitation Zone (restricted to existing tractor roads in Unit #8) would maintain understory vegetation, down logs, rocks and forest floor litter to also potentially filter sediments before being delivered to the stream channel.
(4) Based on this scientific information presented in this assessment the WLPZ and SOZ design **meets** the protection measures described in CCR 936.9.

(4a) Non-Anadromous Fish Habitat: Results and Evaluation of Stream Habitat Surveys for Upper McKinney Creek

A field examination and survey was conducted of each Class I watercourse reach that occurred within or adjacent to harvest units in order to identify at a minimum the quantities of pool, flatwater, and riffle percentages within the selected reach (14 CCR 916.4, 936.4, 956.4). One reach of **Upper Mckinney Creek** was surveyed. The survey was conducted on **4/7/06 through 5/5/06** and was completed from point 1 to point 495 for the first reach located on the attached Habitat Survey Map. Manhours required were 105.0 hours. The survey was conducted according to the following protocols:

Habitat Survey Method:	Modified California Salmonid Stream Habitat Restoration, 3rd Edition
Habitat Survey Level:	Level IV
Stream Channel Types:	Bisson et al.(1982), Decker, Overton et al. (1985) and Sullivan(1988)
Channel Assessment Process:	Selected portions of Standard Methodology for Conducting Watershed Analysis (Version 3.0 November 1995), Washington Department of Natural Resources
Results:	(Summary of Field Habitat Survey to Level II standard)

Preliminary Assessment Results:

A preliminary channel assessment was conducted prior to completion of field stream surveys to assess information on past and present stream channel conditions.

Stream Order (Strahler, 1957 based on 1:24,000 scale) ☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5

Total Stream Length: 43,500 Feet 8.24 miles

Total Stream Surveyed: 15,167 Feet 2.87 miles

Percent of Total Stream Length Surveyed: 34.9 %

Perent of Total Stream Length Surveyed above Anadromous Barrier: _____

Stream Survey Results:

Observation of encroachments within the stream flood-plain:

☒ Forest Roads ☐ Urban Roads ☒ Timber Harvest ☒ Mining

☐ Agriculture ☐ Water Diversion ☐ Structures or Dams ☐ Urbanization

Observation of potential barriers to anadromous fish distribution:

Location	Habitat Type	Habitat Length (feet)	Habitat Depth (feet)	Elev. Gain (feet)
2.1 Downstream from Habitat Unit #1				

* Natural barrier verified by California Department of Fish and Game.
The natural barrier is a series of three very large (>10 feet) bedrock boulders.

Based on stream cross sections of flood plain width (FPW) and bank full channel width (BFCW) the channel bed morphology is (*Watershed Analysis standard methodology*):

☐ Unconfined FPW > 4 BFCW ☒ Moderately Confined 2 BFCW < FPW < 4BFCW ☐ Confined FPW < 2 BFCW

Considering the channel gradient and confinement the channel response reach is (*Watershed Analysis standard methodology*): Gradient = 6%

☐ Response Reach (0 – 4%) ☒ Transport Reach (4 - 20%) ☐ Source Reach (> 20%)

Considering the survey results of channel gradient the specific channel response type is (*Watershed Analysis standard methodology*):

☐ Pool-Riffle < 1% ☐ Pool-Riffle Plane-Bed 1 - 2% ☐ Plane–Bed Forced Pool-Riffle 2 – 4 % ☒ Step-Pool 4 - 8% ☐ Cascade 8 – 20% ☐ Colluvial > 20%

Natural Channel Processes:

Considering the channel bed morphology *(Moderately Confined)* and specific channel response type *(Step-Pool)*, what were the *expected versus observed natural channel processes* for this reach (*Watershed Analysis Table E-2 Channel Response Matrix*):

Sediment		Expected	Observed
	Fine Sediment Deposition	☐	☐
	Course Sediment Deposition	☐	☐
	None	☒	☒
Large Woody Debris			
	Large Woody Debris Loss	☒	☐
	Large Woody Debris Gain	☐	☒
Catastrophic Events			
	Debris Flow Scour	☒	☐
*	Debris Flow Deposition	☒	☒
	Dam Break Flood	☒	☐
	None	☐	☐

* At Stream Survey Habitat Type #____ a small (<100 feet) debris flow was found depositing large wood, small wood and both coarse and fine sediment to Upper McKinney Creek. The initiation point is approximately 80 feet above the bank full width channel zone. Large woody debris present on the slope at the time of debris flow is presently help control sediment routing and forming complex fish habitat.

Percent Pool Habitats:

Considering the channel response type, gradient and confinement what are the expected quantity of pools for this reach *(Watershed Analysis Table F-6, Table F-2):*

Expected Percent Pool Habitats	☐ Good	☒ Fair	☐ Poor
Channel: *>5% gradient, <45 ft wide*	> 30%	20-30%	<20%
Observed Percent Pool Habitats	☐ Good	☐ Fair	☒ Poor
Channel: *>5% gradient, <45 ft wide*	> 30%	20-30%	<20%

Habitat Type	Total Length	Percent
Riffles	9554	63
Runs	4250	28
Pools	1363	9
Other	0	0
Total	15,167	100%

LWD Pieces per Channel Width:

Considering the channel response type, gradient and confinement what are the expected quantity of LWD for is reach *(Watershed Analysis Table F-6, Table F-2):*

Expected LWD Pieces per Channel Width	☐ Good > 2	☒ Fair 1 – 2	☐ Poor < 1
Observed LWD Pieces per Channel Width:	☐ Good > 2	☐ Fair 1 – 2	☒ Poor < 1

Mean Bank Full Channel Width	Total Stream Survey Length	Total Number Channel Widths	Total Number LWD Pieces[1]	LWD Pieces Per Channel Width
14	15,167	1083	777	0.72

[1]In water or bank full width.

Assessment of Stream Conditions and Restoration Opportunities:

During the assessment of the Upper McKinney Creek watershed, it became apparent from observed number of pools and accumulations of large woody debris that other factors may be influencing the channel conditions and habitats we observe today. These factors which I refer to a **legacy impacts** can include historic mining, historic logging and road building and use of land for agriculture.

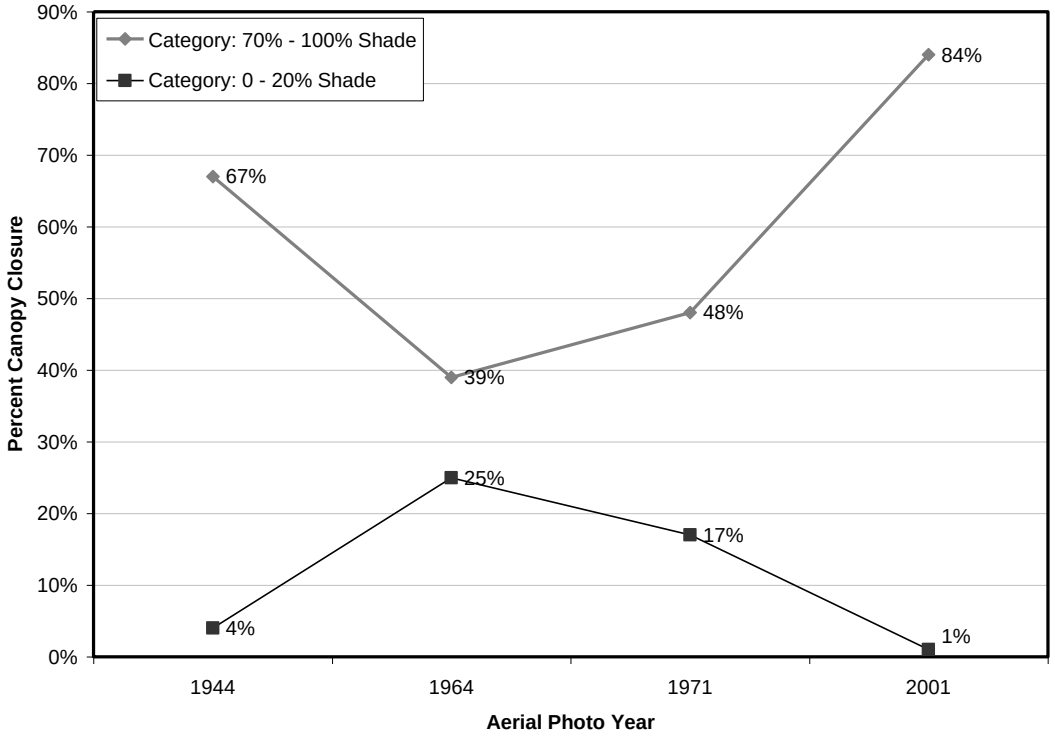
To better understand these potential legacy impacts, a watershed level stream channel assessment was completed for McKinney Creek following standard *Watershed Analysis methodology* (DNR 1995). reviewed. Stream reach levels of shade (canopy closure) and channel disturbance were identified and determined using *Watershed Analysis methodolog*. McKinney Creek was assessed from the confluence with the Klamath River to the headwaters. Aerial photography years reviewed were 1944, 1964 (prior to 1964 flood), 1971(after 1964 flood) and 2001(Table 4)(Figure 2).

Table 4 Results of *Watershed Analysis* methodology for 1944, 1964, 1971 and 2001 photos

Aerial Photo Percent Estimated Shade	1944 Percent of Length	1964 Percent of Length	1971 Percent of Length	2001 Percent of Length
> 90%	47%	20%	32%	66%
70 - 90 %	20%	19%	16%	18%
40 - 70 %	5%	12%	19%	6%
20 – 40 %	14%	15%	7%	0%
0 – 20 %	4%	25%	17%	1%
Class III Headwater	9%	9%	9%	9%
TOTAL	100%	100%	100%	100%

[1] Note that the 1964 aerial photography was taken in August of 1964, the 1964 flood occurred in December of 1964.

Figure 2 Percent of Stream Reaches: Canopy closure



1944 Aerial Photography

Stream Channels and Riparian Habitats: In 1944, the McKinney Creek watershed had a high percent of stream reaches with 70 to 90% and over 90% canopy closure (Table 4)(Figure 2).

Land Use Activities: Several small ranches existed at this time in both Lower and Upper McKinney Creek. Wildfires had occurred but were relatively small (< 500 acres) and little evidence was found for impacts to the stream channel. Roads existed primarily along the McKinney Creek riparian area up to Section 3 T45N R9W. During in-channel stream surveys portions of the historical road (pre-1955) found located within portions of the stream channel and 100-year flood plain. In-channel excavation of the original road prism and drainage structures continues to this day. While not visible from aerial photography (indicating small impacts to vegetation) the impacts to the stream channel from this road location could include: pool filing, channel simplification and channel straightening. Very few roads existed in sub-watersheds of McKinney Creek at this time.

Several small mines are visible. While they appear to have disturbed the stream channel and riparian habitats immediately around each mine, large scale impacts are not visible. A very large mine (> 100 acres) is also visible at the confluence of McKinney Creek and the Klamath river. This mine apparently excavated very large quantities of the stream channel and deposited the gravels on adjacent Klamath River floodplain.

Potential Legacy Impacts: In general, little channel response (i.e. channel widening, braided channel, loss of riparian habitats, creation of depositional gravel bars) was visible in the 1944 aerial photography even though some land use activities had taken place and natural wildfires had occurred. Evidence from in-

channel stream surveys indicated that, while aerial photography show little disturbance, portions of the historical road (pre-1955) were located within the stream channel and 100-year flood plain. The very large mine at the confluence of McKinney Creek and the Klamath river is a lasting legacy impact in 2006. The lower 2,000 feet of McKinney Creek continues to have little complex fish habitat and the stream channels are still exposed to direct solar radition from very low quantities of riparian habitats.

1964 Aerial Photography

The 1964 aerial photography was taken in August of 1964. So these photographs were taken prior to the December 1964 flood that impacted the north coast of California and interior California.

Stream Channels and Riparian Habitats: In 1964, the McKinney Creek watershed had a much lower percent of stream reaches with 70 to 90% and over 90% canopy closure than in 1944 (Table 4). The combined percent canopy closure lowered from 67% in 1944 to 39% in 1964 (Figure 2).

Land Use Activities: Several small ranches that existed in 1944 continued to be operated in 1964. Several large fires (> 500 acres) occurred and evidence was found from impacts to the stream channel including channel widening, braided channel and loss of riparian habitats. The large fires occurred in the eastern and southern portion of the watershed. Extensive new road construction and timber harvesting occurred between 1944 and 1964. Review of a few of the remaining 1955 aerial photographs indicated that some roads and timber harvesting had occurred between 1944 and 1995, however the extensive new road construction and timber harvesting occurred primarily between 1955 and 1964.

Potential Legacy Impacts: Extensive channel response (i.e. channel widening, braided channel, loss of riparian habitats, creation of depositional gravel bars) was observed in the 1964 aerial photography. Numerous reaches of McKinney Creek had channel widening and braided channels which cause the loss of some riparian habitats (Table 1c).

1971 Aerial Photography

The 1971 aerial photography followed the December 1964 flood that impacted the north coast of California and interior California. Little evidence of channel response to a potential flood year was evident. The 1971 aerial photography indicates that McKinney Creek and adjacent watersheds Collins Creek and Barkhouse Creek were not subject to large 1964 flooding as other watersheds in interior northern California.

Stream Channels and Riparian Habitats: In 1971, the McKinney Creek watershed percent of stream reaches with 70 to 90% and over 90% canopy closure was beginning to recover from previous disturbances. Red alder, a pioneer species, is visible in locations where previous channel widening and braided channels existed in 1964. (Table 4). By 1971 dense canopy closure along stream channels had recovered from 39% in 1964 to 48% by 1971 (Figure 2).

Land Use Activities: Several small ranches that existed in 1944 continued to be operated in 1971. Several small fires (< 500 acres) occurred, however aerial photography indicated little channel response to these small fires. Large scale terracing of previous large fires was ongoing in the eastern portion of the watershed. Aerial photography indicates that potential impacts from terracing, previous extensive new road construction and timber harvesting that occurred between 1944 and 1964 is not continuing. Since 1964, vegetation continues to increase along stream channels and evidence of channel disturbance is reduced.

Potential Legacy Impacts: Extensive channel response (i.e. channel widening, braided channel, loss of riparian habitats, creation of depositional gravel bars) observed in the 1964 is recovering by 1971. Numerous reaches of McKinney Creek which had channel widening and braided channels which caused the loss of some riparian habitats are revegetating. (Table 4)(Figure 2).

2001 Aerial Photography

Stream Channels and Riparian Habitats: By 2001, 57 years after the 1944 aerial photography, the McKinney Creek watershed percent of stream reaches with 70 to 90% and over 90% canopy closure currently exceeds amounts visible in 1944. By 2001, the combined percent canopy closure had recovered from a low of 39% in 1964 to 84% in 2001(Figure 2).

Land Use Activities: Several small ranches that existed in 1944 continued to be operated in 2001. Several small fires (< 500 acres) occurred, however aerial photography indicated little channel response to these small fires. New road construction and timber harvesting has occurred between 1971 and 2001. Vegetation continues to increase along stream channels. The 2001 aerial photography indicate little evidence of channel disturbance from recent new road construction or timber harvesting. The aerial photography also indicates no visible long-term legacy impacts from the disturbances between 1955 and 1964.

Potential Legacy Impacts: While extensive channel response (i.e. channel widening, braided channel, loss of riparian habitats, creation of depositional gravel bars) observed in 1964 has recovered by 2001, in-channel stream habitats and recruitment of large woody debris may still be impacted by these legacy impacts.

Do the observed habitats meet or exceed the expected habitat quality:

Natural Channel Processes:

☒ Yes ☐ No If No, explain other observations of channel condition that may be effecting watershed or channel forming processes.

Percent Pool Habitats:

☐ Yes ☒ No If No, explain other observations of channel condition that may be effecting watershed or channel forming processes.

The amount of pools in Upper McKinney Creek were lower than expected. Evidence found during in-channel stream surveys indicated that the historical road (pre-1955) was located within portions of the stream channel and 100-year flood plain. Assessment of aerial photography taken in 1944, 1964, 1971 and 2001 indicated that stream channel response (i.e. channel widening, braided channel, loss of riparian habitats, creation of depositional gravel bars) to natural wildfires, new construction of roads and timber harvesting between 1955 and 1964 likely altered stream channels from natural conditions. The assessment of aerial photography also indicated that basin wide recovery from these natural and manmade disturbances has occurred. However, while riparian and stream channel bank conditions have recovered, in-channel impacts observed in 1964 and from the historic pre-1955 road may still exist. The percent pool habitats may still be impacted by these legacy impacts.

LWD Pieces per Channel Width:

☐ Yes ☒ No If No, explain other observations of channel condition that may be effecting watershed or channel forming processes.

The amount of large wood debris per channel width in Upper McKinney Creek were lower than expected. However, the total amount of pieces per lineal feet of stream channel (1 piece per 20 feet of channel) is relatively high. The mean bank full channel width is relatively narrow (14 feet) for a 3rd order stream.

This relatively narrow channel, and lower than expected amount of LWD per channel width, may be a result of legacy impacts indicated by aerial photography assessment.

Assessment of aerial photography taken in 1944, 1964, 1971 and 2001 indicated that stream channel response to natural wildfires, new construction of roads and timber harvesting between 1955 and 1964 likely altered stream channels from natural conditions. The assessment of aerial photography also indicated that basin wide recovery from these natural and manmade disturbances has occurred. However, while riparian and stream channel bank conditions have recovered, in-channel impacts observed in 1964 may still exist. The narrow channel width and lower LWD per channel width may still be impacted by these legacy impacts.

Does the proposed Timber harvest Plan have any mitigation measures that will contribute towards the restoration of stream conditions that are below what would be expected:

☒ Yes ☐ No (If yes, describe location in THP)

A summary list of benefical measures incorporated into the proposed THP may be found under Item #26 and Item #38

Specific measures incorporated into the proposed THP to increase LWD recruitment which may increase stream pool habitat formation into the future: (1) No harvest 50 foot buffer and additional 100 feet buffer of 50% canopy closure on Class I WLPZ; the 50 foot buffer is where 94.3% of all LWD is currently being recruited from. (2) Retention of all trees within 50 feet in Class I WLPZ should provide 100% effectiveness in retaining root stability and maintaining stream channel stability along Class I WLPZ.

Considering the results of the preliminary channel assessment, stream survey results, stream survey assessment and existing Timber Harvest Plan mitigation measures, *are there additional restoration opportunities within this stream reach*:

☐ Yes ☒ No (Explain if needed)

4(b) Large Woody Debris: Delivery to Stream Channels

Large woody debris found in stream channels control stream flows and formation of fish habitat (McDade et al., 1990). A variety of mechanisms can deliver large woody debris to the stream channel including; windthrow, stream bank erosion, landslides, floods and wildfires. The majority of large woody debris that helps form fish habitat is recruited at relatively close distances to the stream channel (Murphy and Koski (1989)), however, large woody debris can potentially enter the stream channel from up to one site potential tree height (FEMAT 1993). The probability that a falling tree will enter the stream is a function of slope distance from the channel in relation to tree height (McDade et al., 1990). To design riparian habitat management plans it is helpful to understand the recruitment mechanisms and understand the recruitment distances of large woody debris.

As part of the detailed stream channel level IV survey conducted (Section 4a), the size, type, source and recruitment distance of large woody debris was measured following the protocols described by McDade et al., 1990. One reach of stream was surveyed in the Etna Creek watershed. A total of 15,167 feet of stream channel was surveyed along Upper McKinney Creek and a total of 777 pieces of large woody debris were found in the stream channel. Using *Watershed Analysis* (Section 4a) protocols it was determined that for a confined channel bed morphology and step-pool response type the quantity of large woody debris found (2.61 pieces/channel width) exceeded the quantity of large woody debris for this type of stream channel. It

was also determined that the quantity of pool habitats (>30%), within this channel morphology and response type, exceeded the expected value.

Results of field surveys show that large woody debris has been delivered Upper McKinney Creek stream channel from a variety of sources (Table 5). From the total 777 pieces the source and mechanism of each piece of large woody debris was identified for 402 pieces or 52 percent. Mechanisms that occur at relatively close distances to the stream channel including bank erosion and windthrow (vegetative disturbance), accounted for 74 percent of identifiable wood. Trees in various levels of decay accounted for 17.7 percent of the identifiable large woody debris. ***The source distance assessment found that 100 percent of all identifiable large woody debris was recruited within 100 feet of the stream channel (Figure 3). In addition, 94.3 percent was recruited from within 50 feet and 86.6 percent from within 30 feet of the stream channel***. These results are similar to findings found in coastal Oregon and Washington (McDade et al., 1990), central Washington state (Benda and Sias 1998) and in coastal redwood forests in California (Benda 2004).

Assessment of the Proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Water Class Slope %	Class I WLPZ width (feet)	Protection Measures	Canopy Closure
All Slope Classes	0 to 50 feet	Q	100% retention of existing canopy closure No harvest Alternative
All Slope Classes	50 to 150 feet	Q	50% canopy closure

Based on the site specific observed habitat conditions and assessment does the proposed WLPZ and SOZ prescriptions meet or exceed the protection measures described under 936.4(b) for vegetation structure and 936.6(a) and 936.9(i) for the beneficial function of riparian zones?

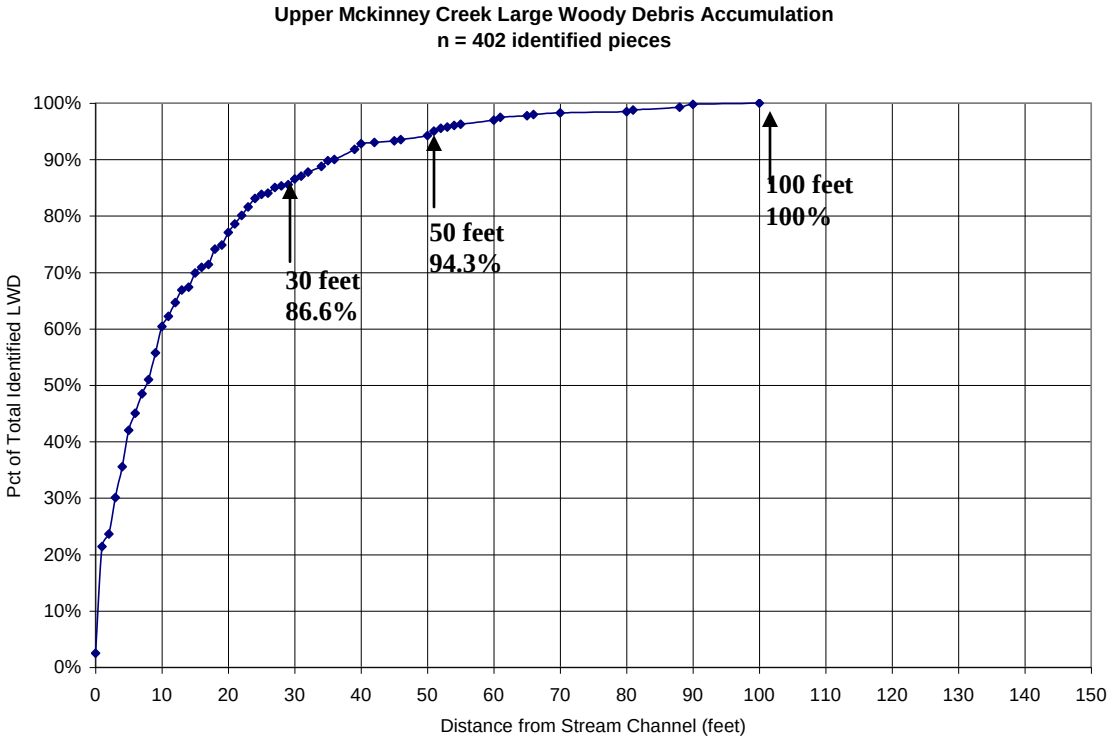
☒ **Yes** ☐ **No** Explain and justify proposal or explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat processes.

(1) The proposed WLPZ was designed to increase potential recruitment from within 50 feet of the stream channel where 94 percent of all large woody debris is currently recruited.
(2) The proposed WLPZ and SOZ also maintain existing recruitment potential for distances greater than 50 feet (currently beyond known measured recruitment distances of 100 feet for the 150 foot Upper McKinney Creek zone)

Table 5 **Upper McKinney Creek Large Woody Debris Source**

LWD Source	Total LWD (pieces)	Identified LWD (pieces)	Identified LWD (%)
Bank Erosion	134	134	33.3
Decay	71	71	17.7
Jam Wood	214		
Manmade	31	31	7.7
Vegetative Disturbance	162	162	40.3
Unidentified	161		
"LA"	4	4	1
TOTAL	777	402	100

Figure 3



(5) Channel Stabilization: Root Strength

Root systems along active stream channels stabilize banks, allow development and maintenance of undercut banks, and protect banks during large storm flows (Sedell and Beschta 1991). Root strength provided by conifer and hardwood trees and shrubs contribute to slope stability. Researches have found that root strength of vegetation can influence stream channel stability within one half a tree crown diameter. The contribution of root strength to maintaining streambank integrity also declines rapidly at distances greater than one-half a crown diameter (Burroughs and Thomas 1977; FEMAT 1993). This maximum distance that root strength can stabilize stream channels for local conifer and hardwood trees species is assumed to be 30 feet.

Assessment of the proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Do the measures proposed by this alternative WLPZ and SOZ based on the site specific observed habitat conditions and assessment ensure the proposed WLPZ and SOZ prescriptions meet or exceed channel stabilization function.

☒ Yes ☐ No Explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

The proposed WLPZ and SOZ were designed based on the scientific understanding of riparian habitats stabilized channels. The proposed measure retains 100% of all vegetation and conifer and hardwoods trees that would be expected to provide rooting strength to the stream channel. Based on the scientific information presented this WLPZ and SOZ design exceeds the protection measures described in CCR 936.9.

Summary of Channel and Riparian Assessment

Key Functions of Riparian Habitat	Meets Protection Standard Described in 936.9	Exceeds Protection Standard Described in 936.9
Riparian Shade	**X**	
Nutrients		**X**
Filtration of Sediment: Maintaining Water Quality	**X**	
Large Woody Debris: Fish Habitat		**X**
Large Woody Debris: Delivery to Stream		**X**
Channel Stabilization: Root Strength		**X**

Terminology:

California Salmonid Stream Habitat (Level IV)

BFCW - bank full channel width

BRS - bedrock sheet

FPW - flood plain width

HU - habitat unit

LWD - large woody debris

PLP - plunge pool

References Cited:

Benda, L. 2004 Wood Recruitment to Streams on the Mendocino Coast, California. Report to Campbell Timberland Management, Fort Bragg CA 95437. 18 pp.

Benda, L. and J.C. Sias 1998 Landscape controls on wood abundance in streams. Washington Forest Protection Association. 60 pp.

Bestcha, R.L. and R.E. Bilby, G.W. Brown, L.B. Holtby, T.D. Hofstra. 1987 Stream temperature and aquatic habitat: fisheries and forestry interactions. Pg 191-232 University of Washington. College of Forest Research, Seattle, WA.

Bibly, R.E. and G.E. Likens. 1980 Importance of organic debris dams in the structure and function of stream ecosystems. Ecology, 61:1107-1113.

Bisson, P. A., J. L. Nielsen, R. A. Palmson, and L. E. Grove. 1982. A system of naming habitat types in small streams with examples of habitat utilization by salmonids during low stream flow. Symposium on acquisition and utilization of aquatic habitat inventory information. Western Division, American Fisheries Society. Bethesda, Maryland.

Brown, G.W. 1970 Predicting the effect of clearcutting on stream temperature. Journal of Soil and Water Conservation. 25(1):11-13

Brown G.W. and G.W. Swank and J. Rothacher 1971 Water temperatures in the Steamboat drainage. USDA Forest Service Research Paper PNW-119. Portland OR 17pp.

Brown, G.W. 1972 The Alsea Watershed Study. Vol XXXII In: Pacific Logging Congress 1972 Loggers Handbook.

Burroughs, E.R. and B.R. Thomas. 1977. Declining root strength in Douglas-fir after felling as a factor of slope stability. USDA Forest Service Research Paper INT-190. Ogden UT 27 p.

Decker, L, K. Overton, et. Al. 1985. Habitat classification and inventory in northern California. Cooperative Habitat Evaluation Studies, USFS/DFG, unpublished, Eureka, California.

Department of Fish and Game. 1994. California Salmonid Stream Habitat Restoration Manual. 2nd Edition. State of California, Resources Agency.

Forest Ecosystem Management: An Ecologocial, Economic and Social Assessment (FEMAT). 1993 J.W. Thomas Team Leader. U.S. Department of Agriculture, U.S. Department of Interior, Environmental Protection Agency, U.S. Department of Commerce.

Gregory, S.V. and F.J. Swanson, W.A. McKee, K.W. Cummins. 1991. An ecosystem perspective of riparian zones: focus on links between land and water. BioScience. 41:540-551.

Lewis, T.E. and D.W. Lamphear, D.R. McCanne, A.S. Webb, J.P. Krieter, W.D. Conroy 2000. Regional Assessment of Stream Temperatures Across Northern California and their Relationship to Various Landscape-Level and Site-Specific Attributes. Forest Science Project. Humboldt State University Foundation. Arcata CA 420 pp.

Lisle, T. 2002 Peer Review of Interim Report for French Creek Watershed Advisory Group. USDA Forest Service, Pacific Southwest Experiment Station.

McDade, M.H. and F.J. Swanson, W.A. McKee, J.F. Franklin, J.Van Sickle. 1990. Canadian Journal of Forest Resources. Vol. 20. p.326-330.

Murphy, M.L. and K.V. Koski. 1989 Input of woody debris in Alaska streams and implications for streamside management. North American Journal of Fisheries Management. 9:427-436.

Power, J. and S. Hilton. 2002. Interim Report for French Creek Watershed Advisory Group. USDA Forest Service, Pacific Southwest Experiment Station.

Quigley, D. and S. Farber, K. Conner, J.Power, L. Bundy 2001 Water Temperatures in the Scott River Watershed in Northern California. Prepared for the US Fish and Wildlife Service. September 20, 2001 50pp.

Sedell, J.R. and R.L. Beschta. 1991 Bringing back the "bio" in bioengineering. Fisheries bioengineering. American Fisheries Society. 10:160-175.

Spence, B.C. and G.A. Lomnicky, R.M. Hughes, R.P. Novitzki 1996 An Ecosystem Approach to Salmonid Conservation. Report to NOAA Fisheries. Management Technology. 355 pp.

Strahler, A. N. 1952. Hypsometric analysis of erosional topography. Bull. Geol. Soc. Am., 63, 1117-42.

Sullivan, K. 1998. Hydraulics and fish habitat in relation to channel morphology. Doctoral dissertation. Johns Hopkins University. Maryland.

Sullivan, K.J. and K. Doughty, J.E. Caldwell, P. Knudsen. 1990 Evaluation of prediction models and characterization of stream temperature regimes in Washington. TFW WQ3-90-006. Washington Department of Natural Resources.

Washington Department of Natural Resources (DNR). 1995. Standard methodology for conducting watershed analysis, version 3.0. November 1995.